CHAPTER 9

MINING

BMP 9-1
MINERAL EXPLORATION

DEFINITION

Best Management Practices (BMPs) utilized in the management of exploration or development drill sites.

PURPOSE

To minimize erosion, sedimentation and other environmental pollution which is generated during mineral exploration or development drilling operations.

APPLICABILITY

Applicable to all mineral exploration or development drilling activities where a surface disturbance occurs.

PLANNING CRITERIA

The Nevada Division of Environmental Protection, Bureau of Mining Regulation and Reclamation regulates mineral exploration and mining operations within the state of Nevada. Federal land management agencies and some local governments also regulate mineral exploration and mining operations. **Before any mineral exploration is initiated, the appropriate federal, state and local permits should be obtained**. The Nevada Division of Water Resources regulates drilling and drill hole plugging activities. Specific regulations govern these activities and any proposed mineral exploration project should review the applicable requirements. Drill holes are potentially direct conduits to ground water sources and as such, represent a significant threat to ground water quality. The proper closure and abandonment of drill holes is a high concern.

Selection of BMPs for mineral exploration or development drilling are governed by the specifics of the site (i.e. topography, elevation, precipitation, vegetation, etc.). Activities typically involved in exploration projects may include: road building, drainage crossings, drill pad construction, trenching, mud pit construction, and heavy equipment transport and use. A variety of BMPs may be required as described in the following sections of this document.

* Road and Construction Site Practices
* Erosion and Sediment Controls
* Soil Stabilization Practices
* Slope Stabilization Practices
* Infiltration Systems

* Watershed Management
* Waste Management
* Miscellaneous

Proper mineral exploration or development drilling activities require comprehensive pre-disturbance planning, project engineering design and installation specifications, a conscientious commitment to proper maintenance and reclamation practices. Project management scheduling and management typically lend themselves to concurrent reclamation as phases of the drilling are completed.

METHODS AND MATERIALS

A qualified professional should be selected to assist in the project design through reclamation phases. Close coordination with the applicable federal, state and local agencies is necessary. BMPs selected should be properly designed and installed per the engineering specifications.

MAINTENANCE

A site specific maintenance and repair program should be developed with a mineral exploration or development project. Proper maintenance is critical to the effectiveness of selected BMPs and the minimization of erosion and sedimentation.

EFFECTIVENESS

A well planned, designed, implemented and reclaimed mineral exploration project can be successfully completed with minimal impacts to surface and ground water quality.

BMP 9-2
EXCAVATION STABILIZATION

DEFINITION

Stabilization of mined surfaces to prevent erosion, sedimentation and the degradation of surface and ground water quality.

PURPOSE

To prevent discharge of sediments or other pollutants into stream channels, drainage ways or waters of the state.

APPLICABILITY

Stabilization practices are applicable to surface disturbances resulting from mining activities that are subject to forces of erosion.

PLANNING CRITERIA

The Nevada Division of Environmental Protection, Bureau of Mining Regulation and Reclamation regulates mineral exploration and mining operations within the state of Nevada. Federal land management agencies and some local governments also regulate mineral exploration and mining operations. **The applicable agencies must be contacted and coordinated with before initiating mineral excavations within the state of Nevada.**

Nonpoint source impacts to surface and ground water quality from mine excavation activities may be prevented or minimized by properly designing and implementing stabilization and reclamation practices. The majority of potential water quality impacts can be averted by upfront planning before land disturbance is initiated. Planning elements to consider include: design and siting of the mine site, facilities, haul and access roads; mining operations and maintenance; design and implementation of sediment and erosion controls prior to surface disturbances; proper mine closure procedures; and for concurrent and final reclamation activities consistent with federal and state regulations.

Various methods are available for stabilizing mine surfaces. Decision as to the appropriate type should be based on careful consideration of the specifics of the site including: magnitude of problem, installation requirements, local conditions, and future maintenance requirements. Topsoil should be stockpiled in conjunction with any disturbance to assist in reclamation efforts.

METHODS AND MATERIALS

General BMPs for mine excavations are described below. Site specifics may require more detailed design and engineering. **A qualified professional engineer should be consulted where appropriate**. A variety of BMPs may be required as described in the following sections of this document.

* Road and Construction Site Practices
* Erosion and Sediment Controls
* Soil Stabilization Practices
* Slope Stabilization Practices
* Infiltration Systems
* Watershed Management
* Waste Management
* Miscellaneous

1. Open Pit Backfilling & Stabilization

Depending upon the type of deposit, the geochemistry of the rock, and water (if present) in the pit, backfilling or partial backfilling, can be a viable means for stabilization and reclamation. Backfilling will typically be compatible with post-mining land uses and management objectives, reduce visual impacts and minimize the impoundment of surface water.

There are three types of backfilling which can be accomplished concurrently or at the end of mining.

Total Backfilling - Potentially extends the duration of the project and may not be economically feasible, but this is balanced against returning the landform more nearly to its original configuration.

Partial Backfilling or Screen Slope Backfilling - This practice is typically done to modify or conceal visual impacts and to increase slope stability of the pit walls. Sometimes utilized as a compromise to total backfilling.

Concurrent Backfilling - Commonly done at mine sites with multiple pits where production schedules can accommodate direct placement of waste rock in an open pit. This method is advantageous because it is cost effective, reduces the size, extent and reclamation of waste rock dumps and allows for a productive post-mining land use.

2. **Highwall Stabilization**

The configuration of a highwall including: the highwall, the overall slope angle, and the bench heights/widths should be designed based upon site specific factors such as rock alteration(s), rock types(s), structure, rock competency and the individual weathering characteristics of each lithologic unit. Slopes created by a mining operation are required by Nevada state law, to be in a stable condition at final reclamation.

The stabilization or reclamation of pit highwalls may range from leaving the highwall stand, to scaling it down or backfilling it to some extent. Fencing or berming is typically incorporated into final reclamation to protect the safety of the public.

3. **Trenches & Bladed Areas**

The stabilization of trenches and bladed areas includes the following elements.

* Topsoil should be stockpiled separate from any subsoil or bedrock materials.

* Utilization of mechanical hoes results in less surface disturbance than bulldozers.

* Trenches should be reclaimed immediately or stabilized by reducing the slope of the walls. If the trench is not immediately reclaimed sediment and erosion control measures should be implemented, and hazards to people, livestock and wildlife addressed.

* The reclamation of trenches and bladed areas includes backfilling, regrading to the original slope and contour, spreading of the stockpiled topsoil and revegetating the disturbed area.

4. **Placer Operations**

Placer operations typically involve the disturbance of stream management areas, including the stream bed. The control of sediment and erosion becomes more difficult and requires the design and installation of sediment and erosion control structures, usually in series. Impacts to riparian and aquatic vegetation, fisheries and wildlife habitat all become concerns which must be addressed. **Coordination with federal, state and local regulating agencies is necessary**. **Qualified professionals are recommended for the design and implementation of placer operations**.

MAINTENANCE

A comprehensive maintenance program should be developed for all mine excavation operations. Regular maintenance is necessary throughout the life of the mine, design, development through closure and reclamation. The project area must be left in a stable condition for long term recovery as required by state and federal law.

EFFECTIVENESS

When properly designed, installed and maintained mine excavation and stabilization practices should be an effective means to control erosion, prevent soil loss, and protect water quality.

NOTE:

For specific guidance on excavation stabilization refer to U.S. Soil Conservation Service Technical Guides, U.S. Forest Service Handbooks, U.S. Department of the Interior - Bureau of Land Management Mining Regulations and handbooks, and the Nevada Division of Environmental Protection, Bureau of Mining Regulation and Reclamation.

BMP 9-3
SURFACE RUNOFF MANAGEMENT

NOTE

Nevada is an authorized National Pollutant Discharge Elimination System state, and its stormwater program covers all active and inactive mine sites with a general stormwater permit; as such, mines are treated as point sources for purposes of the permit.

Areas **NOT** covered by this program are: haul roads constructed of conventional materials and not subject to spillage, parking lots, reclaimed areas released from bond, grassy areas, office buildings, and areas released from bond that are inadequately reclaimed.

Stormwater coming in contact with "industrial" areas of mine sites will be permitted. Examples of industrial areas include: industrial buildings, haul roads constructed of waste rock or spent ore or which are used to transport industrial materials, milling, concentrating and processing areas, waste rock dumps, spent ore dumps, chemical and fuel storage areas, and truck wash areas.

NPDES and stormwater general permits do not apply once the mining site has met closure and reclamation requirements.

BMPs should be implemented on all mining and mining related sites to prevent, control and minimize nonpoint source pollution and to protect water quality. BMPs throughout this manual are provided as guidance and should be selected and applied on a site specific basis appropriate to the goals and objectives of the project, existing environment and site management requirements.

DEFINITION

BMPs utilized to manage surface or stormwater runoff from mine sites and all ancillary facilities including areas being reclaimed, areas covered by NPDES permits and sites not subject to permit requirements.

PURPOSE

To prevent and control nonpoint source pollution impacts to surface and ground water from mine site stormwater runoff.

APPLICABILITY

Surface or stormwater runoff management practices are applicable to all mining industry related sites, active, inactive, temporarily closed or reclaimed.

PLANNING CRITERIA

Surface or stormwater management practices should be incorporated into permit requirements as per regulation, and should be accepted protocol for mining related sites, operations, designs and project planning. A mine site which had or has the potential for acid rock drainage, metal leaching or related water quality concerns should be particularly concerned with surface water management.

A risk identification and assessment of the potential pollution or contaminant sources should be completed. Data should be gathered for each contaminant source including: type, quantity, characteristics, toxicity, mobility and the potential for release to surface or stormwater flows. A contingency plan should also be developed which addresses each of the existing or potential contaminant sources. Monitoring may also be a necessary component to stormwater management. The gathering and compiling of baseline data on stormwater quality will clarify agency concerns and protect all involved.

Employee training on the components of the stormwater runoff management program, practices, good housekeeping and maintenance related to those practices should be implemented on a timely basis.

METHODS AND MATERIALS

The development of a stormwater runoff management program may require the expertise of a qualified professional engineer. Coordination with the appropriate federal and state regulatory agencies is also necessary. A variety of BMPs may be required as described in the following sections of this document.

* Road and Construction Site Practices
* Erosion and Sediment Controls
* Soil Stabilization Practices
* Slope Stabilization Practices
* Infiltration Systems
* Watershed Management
* Waste Management
* Miscellaneous

MAINTENANCE

A comprehensive maintenance plan should be developed and incorporated into the stormwater runoff management program. Regular maintenance particularly after contaminant spills, precipitation and storm events is necessary. Identified problems should be repaired immediately, prior to the next storm event.

EFFECTIVENESS

Stormwater runoff management practices when designed, installed and maintained properly are effective methods to treat nonpoint source pollution and minimize impacts to surface and ground water quality.

BMP 9-4
WASTE ROCK DUMP MANAGEMENT

DEFINITION

The management, handling and construction of waste rock dumps comprised of waste rock generated by mining activities.

PURPOSE

To provide guidance for waste rock management for the expressed purpose of preventing and controlling erosion, improving slope stability and reclamation success, and minimizing impacts to surface and ground water quality.

APPLICABILITY

Mine waste rock management and waste rock dump construction practices are applicable to all active, inactive, or potential mine sites and mine sites in temporary closure.

PLANNING CRITERIA

The proper management and handling of waste rock and the proper design and construction of waste rock dumps has a direct effect on slope stability, closure and reclamation success. Generally speaking, a reduction in the degree of waste rock dump fill slopes results in improved slope stability and improved revegetation potential. **Mining operations and associated waste rock dumps are regulated by the Nevada Division of Environmental Protection, Bureau of Mining Regulation and Reclamation (NAC 445.242 to 445.24388 and NAC 519A).** Final waste rock configurations, stability and revegetation are all components of the mining operations reclamation permit as defined by NAC 519A. Waste rock should be sampled and characterized for acid generation potential, reactivity, metals and other parameters that might be of concern, so the material can be handled, stored, disposed and reclaimed successfully.

Upon completion of waste rock characterization the selective placement and construction of waste rock dumps must be considered. This should be completed during the mine planning, design and environmental analysis or pre-disturbance phase of the project. The design and construction of waste rock dumps should consider topography, drainage ways or streams, slope stability, dump surface drainage, reclamation and revegetation aspects. Waste rock dumps should blend with the existing topography to minimize visual impacts. Waste rock can also be utilized to backfill open pits, construct mine roads or haul roads and other areas where material may be needed.

METHODS AND MATERIALS

The management and handling of waste rock, including the design and construction of waste rock dumps requires the expertise of a qualified professional mine engineer. There are also numerous publications regarding mining and mine waste rock available from the federal land management agencies, mineral research centers and universities.

The most common types of mine waste rock dumps include: Head of Valley Fills; Cross Valley Fills; Side Hill Dumps; and Flat Land Pile Dumps.

MAINTENANCE

Mine waste rock area management and mine dump design and construction should be included within the overall mine site maintenance program. Regular inspections are necessary, particularly after precipitation or storm events and repairs should be made immediately. Surface and ground water quality monitoring is recommended and often a permit is required.

EFFECTIVENESS

When properly designed, installed and maintained, mine waste rock management practices are effective means of reducing or preventing erosion, sedimentation and contaminant mobilization, improving reclamation success and reducing public safety risks.

BMP 9-5
IMPOUNDMENT MANAGEMENT

DEFINITION

The management of tailings ponds and dams, fresh water impoundments, dewatering infiltration ponds and impoundments, and any other mining facility impoundment.

PURPOSE

To design, install and manage mining impoundments in a manner which prevents erosion and sediment mobilization, controls surface runoff and minimizes pollution impacts to surface and ground water quality.

APPLICABILITY

Proper impoundment design, installation and management practices are applicable to all active, inactive, or potential mine sites and mine sites in temporary closure. **Mining operations and mineral exploration projects are regulated by the Nevada Division of Environmental Protection, Bureau of Mining Regulation and Reclamation (NRS Chapter 445 and NAC Chapter 445.242 through 445.24388. Additionally dams designed and constructed within the state, water wells and related drilling practices are regulated by the Division of Water Resources, State Engineers Office**.

PLANNING CRITERIA

The design, construction and management of an impoundment requires the expertise of a qualified professional engineer. Additionally, comprehensive site specific investigations are necessary including: geological, hydrogeological, soils, hydrologic and related environmental analysis.

Depending upon the specifics of the site, surface water diversions are typically designed and constructed in conjunction with the design and construction of an impoundment facility. Surface diversions are utilized to decrease the amount of runoff water entering the impoundment and to reduce the potential for stormwater or a storm event damaging the facility. Surface diversion BMPs include: diversion dikes/berms, interceptor dikes/berms, interceptor trenches and related sediment and erosion control treatments.

Ground water related concerns include the migration of impoundment fluids into the ground water and the seepage or incursion of ground water into the impoundment area. Practices to prevent these potential concerns include the following:

1. Installation of a liner or liners to prevent leachate and/or process chemicals from coming into contact with ground water. Liners may include recompacted soils, impervious clay, synthetic materials (i.e. polyvinyl chloride-PVC, high-density polyethylene- HDPE, etc.) or a combination there of.

2. Installation of a drainfield and/or collection system under the liner to prevent seepage from building up between the liner and saturated soil underneath the impoundment.

Air quality concerns regarding fugitive dust are a common problem with tailings impoundments which are in temporary closure, closure or abandonment. NDEP, Bureau of Air Quality is responsible for fugitive dust management (NAC 445.734 Fugitive Dust). Typical treatments to control fugitive dust include the application of water and/or chemical tacifiers, compaction, or covering the site with larger size material such as waste rock.

Typical management practices for impoundments include the following components.

* Routine inspections
* Established monitoring as required by permit
* Regular maintenance as specified in a comprehensive maintenance program
* Erosion prevention and control measures
* Dust management
* Controlled access through fencing or other measures
* Emergency contingency plans
* Concurrent reclamation and revegetation

METHODS AND MATERIALS

Impoundments and tailings ponds must be designed, installed and maintained according to approved engineering plans and specifications specific to the site. **Engineering plans and specifications should be prepared by a qualified professional engineer**. Throughout the construction phase regular inspections and documentation is necessary. As built plans which accurately represent the final project, should also be prepared.

MAINTENANCE

A comprehensive maintenance program should be developed in conjunction with the project. The impoundment facilities must be inspected and maintained on a regular basis, particularly after precipitation or storm events. Identified problems must be repaired immediately, prior to the next storm event.

EFFECTIVENESS

Appropriate management practices developed site specifically for impoundments and tailings ponds are a very effective means of pollution prevention, erosion control and surface and ground water quality protection.

BMP 9-6
RECLAMATION

DEFINITION

The reclamation of surface disturbances associated with mineral exploration and extraction including the practices of planning, designing, engineering, grading, stabilization, growth medium application, and revegetation. Reclamation provides for physical stabilization of the land surface, but does not include the chemical stabilization of mined lands which is addressed in mine closure activities.

PURPOSE

To prevent, control and minimize erosion and sedimentation, stabilize affected or created slopes, restore surface drainage ways, revegetate surface disturbances, prevent and minimize impacts to surface and ground water quality and to meet post mining land use objectives of the site (i.e. wildlife, recreation, livestock grazing, etc.).

APPLICABILITY

BMPs for the reclamation of surface disturbances associated with mineral exploration and extraction activities are applicable to all active, inactive, or potential mine sites and mine sites in temporary closure. **Mining operations and mineral exploration projects are regulated by the Nevada Division of Environmental Protection, Bureau of Mining Regulation and Reclamation (NRS and NAC Chapter 519A)**.

PLANNING CRITERIA

Mineral exploration and extraction activities should not be the final use of the land. A goal for reclamation activities is to incorporate reclamation into all phases of a mining project, from planning and permitting through closure, to return the subject lands to a safe, stable productive post mining land use consistent with land management objectives. In Nevada a regulatory and permit process is in place for mineral exploration projects and mining operations to ensure that: reclamation is accomplished concurrently, or as soon as possible; exposed soil surfaces, soil loss and erosion are minimized; surface and ground water quality is not degraded; the land is returned to a condition of productivity, consistent with its pre-mining land use and land use objectives; public safety is maintained and visual impacts are minimized; and the costs of reclamation are secured through a surety process.

The following are generally recognized principals of reclamation that should be utilized as guidance for the mineral industry:

a) Reclamation should be incorporated into mineral activities up front and throughout the life of a project, not as an after thought.
b) Contaminants or hazardous/toxic materials should be controlled to prevent impacts to the environment.
c) Surface and ground water quality should be protected.
d) Topsoil or growth medium should be stockpiled and conserved so it can be utilized in the reclamation of disturbed areas.
e) The reclamation of disturbed areas should occur concurrently or as soon as possible to minimize exposed soil surfaces, soil loss, erosion and water quality impacts. Interim reclamation should be incorporated for projects lasting more than one growing season.
f) Final project site grading and shaping should be designed prior to initiating surface disturbances, consistent with sound watershed principles and the productive post-mining land use.
g) The final land morphology should be physically stable to prevent further soil loss, erosion, storm runoff damage and to provide an environment for successful revegetation.
h) A holistic or "watershed" approach should be utilized to analyze the physical, chemical and climatic characteristics of the site to formulate the reclamation plan. Test plots should be developed to test reclamation practices and procedures proposed for the site.
i) The proper equipment should be selected for the site based upon the site specific characteristics (i.e. soils, slope gradients, access, etc.).
j) Successful revegetation requires completion of several primary components including: seed bed preparation, appropriate plant species selection (native, adapted, diversity criteria) which meets post mining land use goals, proper seeding methodology for the site, available moisture or irrigation, and site protection until seedling establishment.

METHODS AND MATERIALS

The field of disturbed site reclamation is evolving rapidly as research and field trials expand. A variety of technical manuals are available from the federal land management agencies, agricultural research agencies, plant materials centers and western universities. The Bureau of Mining Regulation and Reclamation, Division of Environmental Protection can also provide technical assistance and guidance.

A qualified professional should be consulted regarding the design, development and implementation of a comprehensive mine reclamation plan. The following discussion outlines the primary phases of a reclamation plan, but depending on the specifics of the site, additional data collection and analysis may be necessary.

Pre-Disturbance Planning -
The first step is tied closely to the federal and state permitting process and environmental analysis. Given the fact that the vary nature of mineral exploration and recovery varies significantly as drilling information is gathered, a project may evolve significantly over time both in physical size, location and magnitude. While a "best guess" mine plan is the starting point to build a reclamation plan, changes in the mine plan over time require that the reclamation plan be a dynamic tool and regularly updated. Baseline data must be gathered on the project site including but not limited to: topography, soils, geology, surface and ground water quality and quantity, vegetation, wildlife, precipitation, existing land uses and post mining land uses. The baseline data is then utilized to develop a reclamation plan which can be implemented concurrently with the mine plan in a coordinated and economically feasible manner.

Growth Medium/Topsoil Management -
The future productivity and success of disturbed area reclamation is strongly influenced by the amount and quality of growth medium or "topsoil" salvaged. In the arid west many areas have little or no "topsoil" but many subsoils do provide adequate growth medium. Soils must be tested and salvaged accordingly. Depending upon the specifics of the site the management or stockpiling of growth medium may vary significantly to keep the growth medium biologically viable. The initiation of test plots upfront can not be overemphasized to determine the best methods for revegetation.

Sediment, Erosion and Stormwater Control Measures -
The basic activities of mineral exploration and mining operations involve significant surface disturbances and the creation of dumps, impoundments and other exposed slope surfaces. Exposed soils and subsurface materials are primary sources of sediment. The proper control of sediment, erosion and the management of stormwater is critical to prevent and minimize degradation of surface and ground water quality and air quality. **Designed, engineered, constructed and maintained sediment and erosion control structures by qualified professionals is a necessity prior to surface disturbances**.

Shaping and Grading -
Topographic compatibility is necessary between pre-mining and post-mining land forms for several reasons including physical stability, public safety, revegetation and visual aesthetics. The final land form configuration should be designed up front, prior to surface disturbance and designed in such a manner to be consistent with existing topography, facilitate and improve revegetation efforts, minimize surface and ground water quality impacts, control surface drainage and provide for the overall stability of the site. Graded slopes should include a plan or design for water harvesting. Water harvesting techniques include contour furrows, moonscaping, terracing or "cat tracks" along the contours. Pre-planning will significantly improve the economic viability of the project.

Revegetation -
Revegetation activities are comprised of growth medium/soils testing, plant species selection, seed bed preparation, seeding, fertilizing, mulching, irrigation and site protection.

Growth medium/soils testing - The growth medium or soils proposed for reapplication should be tested for viability, toxic constituents, nutrients, pH and productivity. Test results will guide selection of the type and quantity of soil amendments.

Plant species selection - The selection of proper native and adapted plant species is critical to revegetation success and the productivity of post-mining land use. Close coordination is necessary with the federal land manager or the private land owner to select plant species which meet land use objectives, stabilize the surface, are compatible with the growth medium and the specifics of the site, and prevent sedimentation and erosion. Pre-mining vegetation diversity should be a primary component in plant species selection. Plant species with rhizomatous root systems are proven effective in controlling surface erosion.

Seed bed preparation - Surface disturbances and created slopes should be recontoured to approximate the original landform preserving natural drainages or reestablishing them. Final graded surfaces should be ripped to relieve compaction and growth medium reapplied to the maximum depth possible. Seeding should immediately follow, but if it is not possible, the surface may have to be disced or tilled depending on the amount of surface crusting that occurs. Ideally, seed bed preparation will immediately proceed seeding during the fall to early winter of the year.

Seeding - The proper seeding methodology must be selected based upon the specifics of the site, the size, type and depth requirements of the seed and the other revegetation components utilized. Typical seeding methodologies include: broadcast seeding, drill seeding, and hydroseeding. Each has specific requirements, benefits and constraints which should be evaluated. Seeds must be drilled to the proper depth or covered with soil and/or mulch to prevent wind migration and consumption by avians. The most favorable time to seed in Nevada and the arid west is the fall to early winter. Seeds lay dormant until spring until soil moisture and temperatures are optimal for germination and growth.

Fertilizing - Fertilizer and/or soil amendments should be added to the growth medium given the specifics of the site, soil testing results and plant species requirements. Slow release fertilizers haven proven very effective and minimize the potential for over application.

Mulching - Mulching has proven effective in improving reclamation success. Mulching assists in erosion control and soil stabilization, creates a micro climate which moderates temperatures and retains moisture, and it protects seedlings until plant establishment (See Soil Stabilization - Chapter 3). Straw mulches are the most commonly used in revegetation and are either blown on mechanically or spread by hand at approximately

two tons per acre. Mulches must be crimped into the soil, utilized under netting or applied with tackifiers, otherwise they are subject to wind migration.

Irrigation - While not commonly utilized in mining applications, temporary irrigation is by far the best method for ensuring plant species establishment. Temporary irrigation can provide plant species germination and establishment water requirements when nature may not. While temporary irrigation represents additional costs, the benefits of improved plant germination and establishment, rapid soil and slope stabilization and earlier return of sureties out weigh costs. Irrigation water application, (amount and timing), must also be carefully planned to the fall and early winter seasons. Seeding and irrigating earlier in the season is feasible as long as irrigation continues throughout the growing season. If not applied correctly there is a potential for plant growth and die off due to poor weather conditions and lack of water.

Site protection - Revegetation areas must be protected from disturbance until plant species establishment. Site protection is typically provided by fencing, berming and signing to prevent intrusion by livestock, wildlife, motor vehicles and the public.

It is important to emphasize that individual components of a mining operation or exploration project may require specifically designed reclamation treatments. Reclamation must be closely coordinated with closure activities to address potential chemical, hazardous or toxic conditions. Chemical stabilization and closure must occur prior to revegetation efforts so plant species are not negatively impacted.

MAINTENANCE

Maintenance is a primary component of any reclamation plan no matter what the size. A maintenance program must be comprehensive and address all aspects of reclamation throughout the life of the mining plan or exploration project. Maintenance inspections and repairs should be conducted regularly and after all precipitation or storm events. Surface drainage ways, sediment and erosion controls, site protection facilities and revegetation components all require maintenance. Revegetation areas may require reseeding, fertilizing and mulching depending upon the adequacy of the initial treatments.

EFFECTIVENESS

A well designed, implemented and maintained reclamation plan will significantly reduce impacts to existing natural resources, control sediment and erosion and minimize impacts to surface and ground water quality.